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The Patent Office

Cardiff Road
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1. Your reference

RAB.P04779GB

2. Patent application number
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0307307.9

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Atelier Vision Limited
Red Cottage
51 Caswell Lane
Clapton-in-Gordano
Bristol BS20 7RU

Patents ADP number *(if you know it)*

8599607001

If the applicant is a corporate body, give the country/state of its incorporation

Great Britain

4. Title of the invention

Image Processing

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Marks & Clerk
27 Imperial Square
Cheltenham
Gloucestershire GL50 1RQ
Great Britain

Patents ADP number *(if you know it)*

18014

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	10
Claim(s)	Nil
Abstract	Nil
Drawing(s)	6 + 6

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Mark & Clark Date 28.03.03

Agents for the Applicants

12. Name and daytime telephone number of person to contact in the United Kingdom: Richard A. Bailey - 01242 524520

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IMAGE PROCESSING

This invention relates to an image processing or manipulation technique, and in particular to a technique that may be used to enhance our appreciation of 3D depth and form depicted in base 2D images and derivative virtual reality (VR) environments.

When three-dimensional scenes are displayed or depicted using conventional two-dimensional techniques, for example by printing on to paper or the like or displaying on a television, computer monitor or the like, or by projection, although the brain perceives the images displayed as being three-dimensional, there are occasions when the perception of depth in the displayed image is not particularly good. This is thought to be due to the absence of sufficient depth cues in the image to allow the brain to interpret the displayed image fully.

The technique of the invention has been developed from theoretical work identifying a new form of illusionary space which has been termed 'mental projection'. By correctly representing and aligning two projections used by the brain to compose mental images it is possible to induce the brain to replicate depth and form perceptions that could otherwise only be created by directly observing the 'real setting' from which the pictorial information derived.

'Mental Projection' can be achieved/ induced in a number of ways pictorially.

1. By imbuing traditional picture space (perspective projection or photographic/ film record) with the required cues.

2. By using the principles to establish a new picture/ model space to generate novel virtual reality (VR) environments.

It is an object of the invention to provide a system, which may be used in combination with existing techniques, whereby an image may be created or modified to enhance the perception of the depth in the image. In each case, mental projection relies on the incorporation of stimuli from which the brain is able to deduce additional perceptions of depth and form associated with our sense of visual perception.

According to one aspect of the invention there is provided an image processing technique comprising the steps of:

(a) stretching the original image in the Y-direction by a factor falling within the range of 2-7%;

selecting a fixation point and disordering the image centring the disordering operation around the fixation point; and

rotating the image through an angle falling within the range 3-9° clockwise;

(b) stretching a copy of the original image in the X-direction by a factor falling within the range of 2-7%; and

selecting an area of the image around the selected fixation point; and

(c) merging the selected area of the image formed in step (b) with the image formed in step (a).

The image formed as a result of the transformation set out in step (a) will hereinafter be referred to as a Type 1 image, and that produced in the transformation set out in step (b) will be referred to as a Type 2 image.

This technique can be thus be used to:

i) mimic the appearance of the two base projections used by the brain in our projection of the real world by transforming known picture environments.

ii) replicate a typical composition/ structure of these base projections used by the brain to form mental images.

The key to forming a valid composition is the selection of a fixation point, the establishing of a fixation area and the correct imposition of conditions prevailing in 'the fixation volume' and around the interface between the image types. As in real time observation, a fixation point needs to be established on the media. The fixation point is the point around which the various transformations techniques are to be centred. It is thought that the enhanced 3D depth and form cues are established by the brain as it makes relativistic judgements between the information contained within the two image types. Without a central point of alignment (fixation point) from both data sets, it would be impossible to make these calculations. The fixation area establishes an area around the fixation point broadly analogous to the extent of central vision. As such, the fixation area establishes the extent of the image to be subjected to the specific conditions of the fixation volume. The fixation volume is a spherical area of

influence contained within the fixation area. Any form (object), surface or part of a form that projects into this area of influence is projected in the brain as per the qualitative and quantitative characteristics of image type 2 above.

It follows that any other visual reference to objects outside of this fixation volume contained in the fixation area are referenced as per the image type 1 above.

Areas of central vision outside the fixation volume are referenced as per the characteristics of 'peripheral vision'.

There are a number of typical compositions used by the brain which utilise aspects and juxtapositions of the two image types in a way capable of generating the relativistic judgements from which the new cues are deduced.

Images processed in this manner are thought to conform more fully with our projection of real-time observations (mental images) allowing the brain to correctly interpret a fuller range of three-dimensional cues from the 2D image or virtual reality setting.

The processing technique may include an additional step of fine tuning the boundary between the images formed in steps (a) and (b).

Step (a) of the processing technique may further include steps of altering the colour saturation by a factor falling within the range of 20-60% and/or decreasing the brightness of the image by a factor falling within the range 10-50%.

The technique defined hereinbefore may be performed using a computer on

image data derived, for example, from a scanner or digital camera, or on digital image data obtained or created from other sources including computer programs. However, it will be appreciated that the technique may be performed in other ways, and the invention is not restricted to the specific arrangements or applications described herein.

The invention will further be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an illustration prior to use of the image processing technique;

Figures 2 and 3 illustrate steps of the image processing techniques;

Figures 4 and 5 illustrate the processed form of the illustration of Figure 1;

Figures 6 to 8 are further views illustrating the effect of the process; and

Figure 9 is a diagram illustrating part of the process.

The invention will, initially, be described with reference to the image illustrated in Figure 1. As can clearly be seen, Figure 1 is a computer generated or virtual reality representation of a vase 10, a cone 12, spheres 14 and cubes 16. As each of the objects illustrated are three-dimensional objects, the illustration uses isometric projections to provide depth cues to be interpreted by the brain in an attempt to make the objects appear to be an accurate representation of their form in three-dimensional space. Each object is isolated from all of the other objects, and no perspective cues to indicate the relative positions of the objects are present. As a result, it is difficult for the brain the interpret the image to determine, for example, the

relative sizes of the objects and their positions in three dimensional space. In the image, both of the cubes are drawn as the same size and are perceived as being the same size despite one being further away than the other.

In accordance with the invention, the base image of Figure 1 is processed to form an image of improved form. This is achieved by taking the image of Figure 1 and performing a transformation thereon whereby the image is stretched in the Y-direction (vertical) by a factor falling within the range 2-7%, preferably about 5%, is disordered and is rotated through an angle falling within the range 3-9° clockwise, preferably 6° clockwise. Figure 2 illustrates the effect of the stretching and rotation of the image, but (for clarity) not the impact of disordering the image. The order in which these operations may be varied, but the values/factors used may need to be varied if the order is not as described.

Another copy of the image is stretched by a factor of 2-7% in the X-direction (horizontal). Preferably, it is stretched to ensure a differential with the image in the previous transformation of around 5%. A fixation point on the image is selected, and an area around the fixation point is selected, the remainder of the image being deleted. The result of this operation is shown in Figure 3, where the centre of the vase has been selected as the fixation point.

The two images produced in this manner are superimposed upon one another. The images may be superimposed using several different techniques. Figure 4 illustrates the effect of taking the image of Figure 2 and simply replacing an area

around the fixation point with the image of Figure 3. Figure 5 illustrates the result of an alternative superimposition technique wherein the two images are overlaid and parts of both images are visible, the vase taking the form of a fused form. The fixation area is the vase; this comprises a combined form fused from both image types 1 and 2 in what at first seems an odd looking conjunction. However, when the centre of the vase is fixated, the two identities are merged by the brain into a single percept. This percept is of a more three dimensional vase. This capacity for increased 3D percept is now extended to all the other objects in the picture. For example the further of the two cubes is now perceived to be larger than the closer cube.

This percept of 3D form and depth is, in some ways, analogous to the percept obtained by perspective space. However, it is now thought that perspective cues are not the principle method by which spatial depth is obtained in central vision. Rather, we see spatial depth and form by a process that involves our visual system making relativistic judgements between two distinct data sets or image types. The arrangement identified above stimulates the brain to engage with this process when observing 2D space, providing us with cues more conversant with our appreciation of real settings.

The new picture space is closer to our actual visual appreciation of our surroundings.

Referring next to Figures 6 to 8, an original digitised photograph of a real

setting is shown in Figure 6. The key to forming a valid composition is the selection of a fixation point and fixation area, and the correct imposition of conditions prevailing in 'the fixation volume.' In the present case, the centre of the bottle has been selected as the fixation point. Figure 7 shows the effect of performing the transformations described hereinbefore, but omitting the disordering operation for clarity, and simply replacing the part of the image around the fixation point on one image with the relevant part of the other image. Items within the fixation area, established round the fixation point, are represented as image type 2 with some of the associated qualitative and quantitative transformations. Outside the fixation area, all objects and surfaces are rendered as per image type 1 with the associated qualitative and quantitative transformations. As can be seen in Figure 7, the boundary 18 between the two images in the merged image is clearly visible. Figure 8 illustrates the result of a modified superimposition technique which removes or reduces the impact of the boundary between the images, and shows the establishment of the fixation volume where all surfaces and objects not contained by the spherical influence of the fixation volume are also rendered as per image type 1.

For example; round the neck of the bottle the stones of the wall, although within the circumference of the fixation area of figure 7, are too far from the bottle to be included in the fixation volume and so are referenced as per image type 1.

For example; one arm of the candelabra penetrates the fixation volume and so is referenced as per image type 2 while the rest of the object is outside this area of

influence and so is rendered as per image type 1.

By comparing Figures 7 and 8 with Figure 6 it is apparent that, in addition to the transformations mentioned hereinbefore, the image which has been stretched in the Y-direction has also been modified by increasing the level of colour saturation and reducing the brightness of the image. The colour saturation has been increased by an amount falling within the range 20-60%, preferably about 40%, and the brightness has been reduced by a factor falling within the range 10-50%, preferably about 30%.

It is thought that images processed using the techniques described hereinbefore are of improved or increased resemblance to mental images projected by the brain. Clear and accurate representation of mental image compositions allows an observer of the 2D rendition to engage in additional computations leading to a more viable perception of the real setting being depicted.

An observer of the transformed image will need to look at (fixate on) the selected fixation point to perceive/ appreciate the additional cues.

In the description hereinbefore reference has been made to a step of disordering the image. Although a number of disordering techniques may be used, a preferred technique is to incrementally disorder the image using, for example, the sunflower-like fractal pattern shown in Figure 9 to reduce the amount of detail visible in the processed image with increasing distance from the fixation point.

It is thought that images processed using the techniques described hereinbefore

provide an improved or increased perception or mental projection of depth to the part of the image around the fixation point. The enhanced perception of depth is apparent both where a viewer views the image through both eyes and when the image is viewed using only one eye.

Although the techniques have been described hereinbefore in relation to the processing of pictures, either in the form of computer generated pictures or photographs, it will be appreciated that this need not be the case and the invention may be applied to a wide range of technologies and display techniques including computer or television displays, projected images, virtual reality displays, animations and printed media.

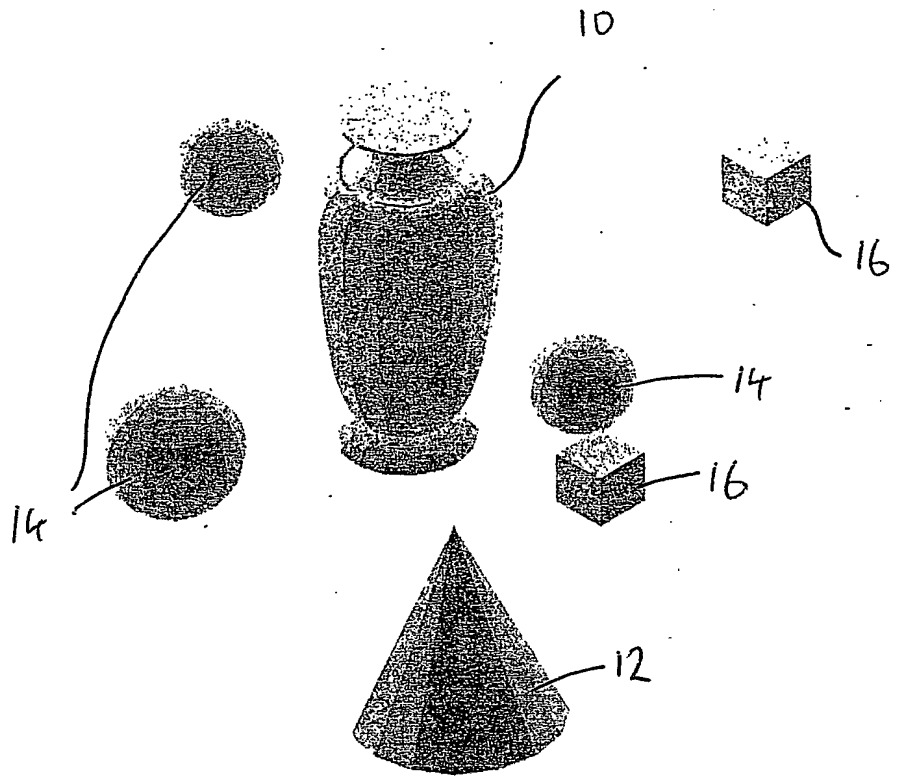


Figure 1

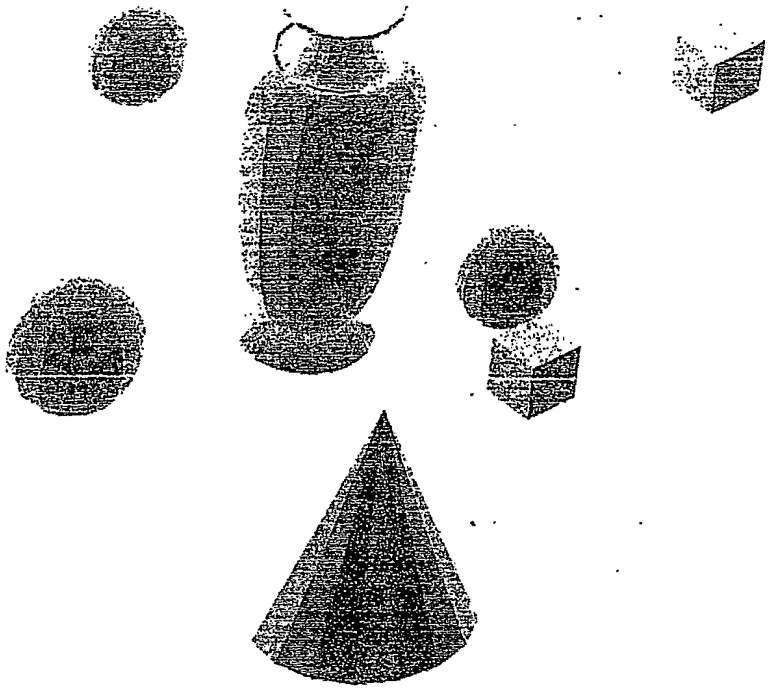


Figure 2

Figure 3

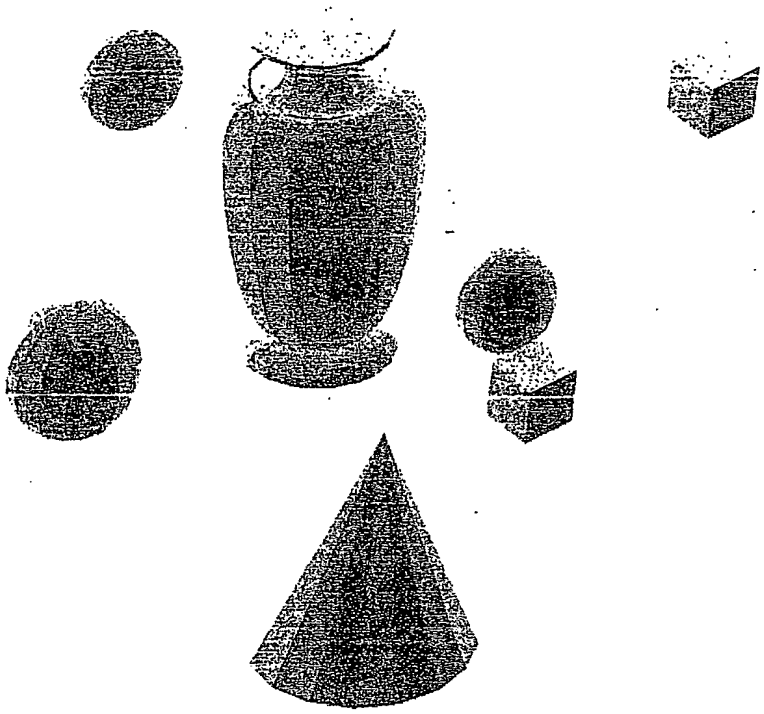


Figure 4

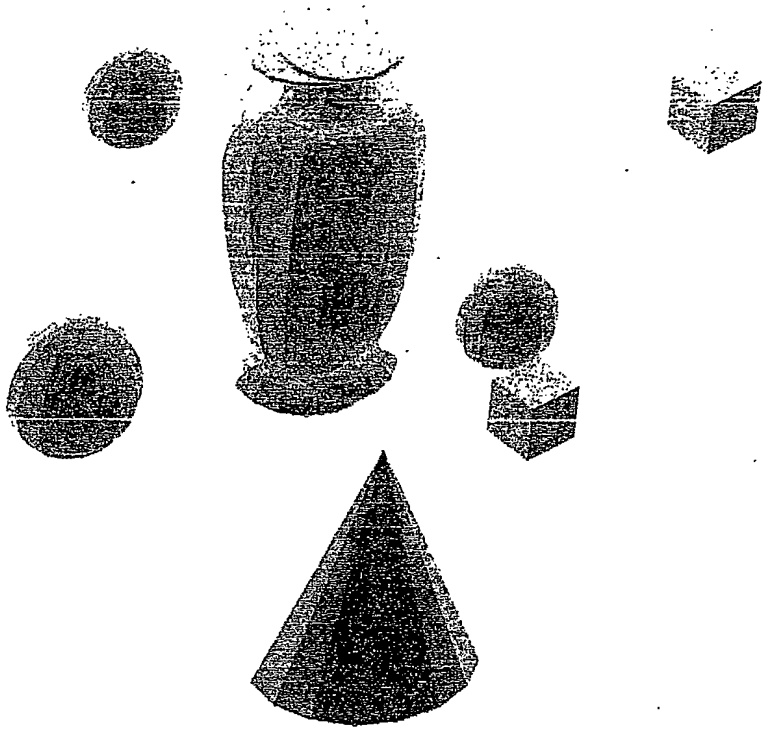
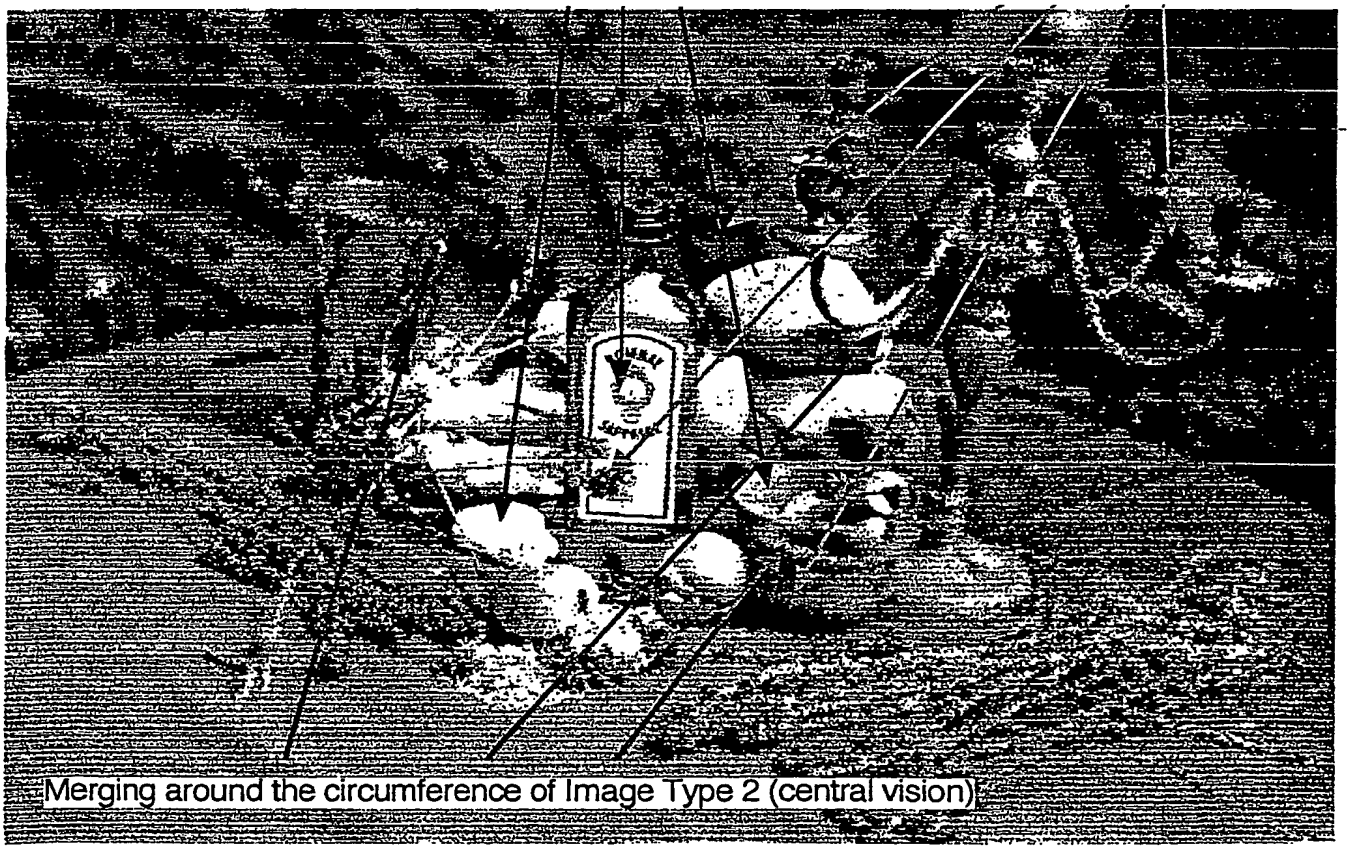


Figure 5

18

Circumference of Image Type 2 (central vision)

Figure 7



Merging around the circumference of Image Type 2 (central vision)

Figure 8

Figure 6

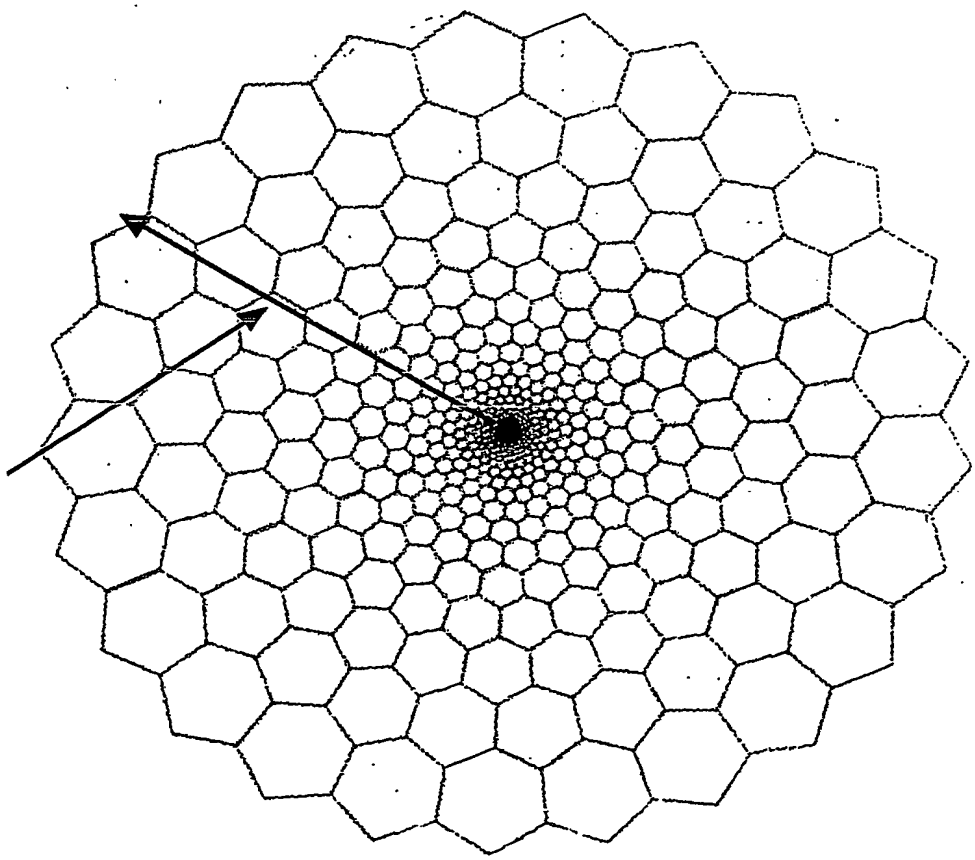


Figure 9